USAFETAC/PR--93/004

"CLOUDIEST YEAR" STUDY

An Analysis of the 3DNEPH AND RTNEPH Databases

by

BILLY D. BAINTER

APRIL 1993

USAF
ENVIRONMENTAL TECHNICAL
APPLICATIONS CENTER

Scott Air Force Base, Illinois 62225-5116

REVIEW AND APPROVAL STATEMENT

AWS/PR-93/004, *"Cloudiest Year" Study--An Analysis of the 3DNEPH and RTNEPh Databases,* April 1993, has been reviewed and is approved for public release. There is no objection to unlimited distribution of this document to the public at large, or by the Defense Technical Information Center (DTIC) to the National Technical Information Service (NTIS).

Mark T. S

MARK SURMEIER
Chief, Special Projects Branch

Billy D Bainter

BILLY D. BAINTER
Writer/Analyst

FOR THE COMMANDER

Geo M. Horn

GEORGE M. HORN
Asst Scientific and Technical Information
Program Manager
2 April 1993

REPORT DOCUMENTATION PAGE

2. Report Date: April 1993

3. Report Type: Project report

4. Title: "Cloudiest Year" Study--An Analysis of the 3DNEPH and RTNEPH Databases

6. Author: Billy D. Bainter

7. Performing Organization Name and Address: United States Air Force Technical Applications Center (USAFETAC), 859 Buchanan St, Scott AFB, IL 62225-5116

8. Performing Organization Report Number: AWS/PR--93/004

12. Distribution/Availability Statement: Approved for public release; distribution is unlimited.

13. Abstract: Describes techniques used to analyze total cloud cover values from the USAF Environmental Technical Applications Center's nephanalysis databases: 3DNEPH and RTNEPH. Object of the study was to determine if total global cloud cover differed significantly on a year-to-year basis. Contoured global maps in an appendix show the results.

14. Subject Terms: METEOROLOGY, CLIMATOLOGY, CLOUDS, CLOUD COVER, NEPHANALYSIS, DATABASES, COMPARISONS, EIGHTH-MESH GRID, WHOLE-MESH GRID

15. Number of Pages: 25

17. Security Classification of Report: Unclassified

18. Security Classification of this Page: Unclassified

19. Security Classification of Abstract: Unclassified

20. Limitation of Abstract: UL

Standard Form 298

PREFACE

This report describes the results of a study undertaken in support of USAFETAC Project 910821, "Cloudiest Year Study." The analyst was Mr Billy D. Bainter, USAFETAC/DOS.

The study was the result of a request from an AF Precedence 1-1 customer who asked for an analysis of USAFETAC's two nephanalysis databases, 3DNEPH and RTNEPH. The customer was concerned that some individual years of cloud data might be unrepresentatively cloudy, perhaps caused by errors in one or both of the nephanalysis models. The specific purpose of the analysis, therefore, was to determine if total global cloud cover differed significantly on a year-to-year basis over a given period of record.

To perform such a study, it was first necessary to reduce the number of eighth-mesh grid points (there were 391,819 of them "on-globe") to a number that would allow cost-effective computation and comparison for the entire 1977-1991 period of record used. "Whole-mesh" grid spacing was used after testing alternatives, such as quarter- and half-mesh.

The study showed that there is no single month in any year that can be said to be the "cloudiest month" worldwide, and that maximum cloud cover varies by year and month according to geographical area. If the customer's concerns were valid, large portions of the globe (if not all of it) would have been identified as having the same "cloudiest year." Instead, the graphics products produced during the study show complex patterns of many different "cloudiest years" over different parts of the world. This conclusion, the result of normal year-to-year and area-to-area climatic variations, was expected.

CONTENTS

1. BACKGROUND. Nephanalysis data from the Air Force Global Weather Central's (AFGWC's) two nephanalysis models (3-Dimensional Nephanalysis, or 3DNEPH, and Real-Time Nephanalysis, or RTNEPH) has been archived by USAFETAC's Operating Location A at Asheville, NC, since 1973. It has been used and applied by USAFETAC analysts since the data became part of the Air Weather Service's overall operational database.

USAFETAC is frequently asked how one year's nephanalysis data compares with another in terms of global cloudiness. Up to now, that question hasn't been answered because of the immensity of the 3DNEPH and RTNEPH databases. But by combining new technologies with a scheme to reduce data volume, USAFETAC/DOS was recently able to rank data by years and months to determine the existence or non-existence of so-called "cloudiest"' periods. The study, the results of which are documented here, used 3DNEPH and RTNEPH data from 1977 to 1991 to determine the years and months with maximum mean total cloudiness.

2. METHODOLOGY

2.1 Nephanalysis Data. The AFGWC automated cloud analysis model became operational in January 1970. First known as "3DNEPH" (3-dimensional nephanalysis), this computer model was developed to allow maximum use of increasing quantities of meteorological cloud information, especially satellite imagery, the heart of the system. The 3DNEPH analysis database is specified at a horizontal resolution of about 25 nautical miles.

The 3DNEPH *horizontal* grid, a subset of AFGWC'S basic horizontal 200-nm macroscale grid, is one-eighth of the 200-nm grid and therefore referred to as the "eighth-mesh" grid. It consists of a 512 by 512 array centered at the poles and oriented on 80 degrees west longitude. The grid is further subdivided into 64 equally sized areas called "3DNEPH boxes."

The 3DNEPH *vertical* grid consists of 15 layers of varying thickness from the surface to 55,000 feet. These 15 layers are divided into two subsets:

- Six terrain-following layers are specified according to local terrain height.
- The other nine layers are specified with respect to mean sea level.

In late 1983 the Real-Time Nephanalysis (RTNEPH)) model replaced 3DNEPH. The newer model uses the same horizontal grid spacing as the 3DNEPH model, but uses four floating layers in the vertical rather than the 15 fixed layers used in 3DNEPH. In addition, RTNEPH data contains source and diagnostic information that improves quality control.

2.2 Periods of Record. Analyses for eight times a day on each synoptic hour (00, 03, 06, 09, 12, 15, 18, and 21Z) are available from both the 3DNEPH and RTNEPH databases, except during the period January 1977 through July 1978 when only 03, 09, 15, and 21Z data is available for the Southern Hemisphere. The table on the next page shows the POR for each hemisphere and data type.

HEMISPHERE	TYPE	POR
North	3DNEPH	January 73 - December 83
South	3DNEPH	January 77 - December 83
North	RTNEPH	January 84 - Present
South	RTNEPH	January 84 - Present

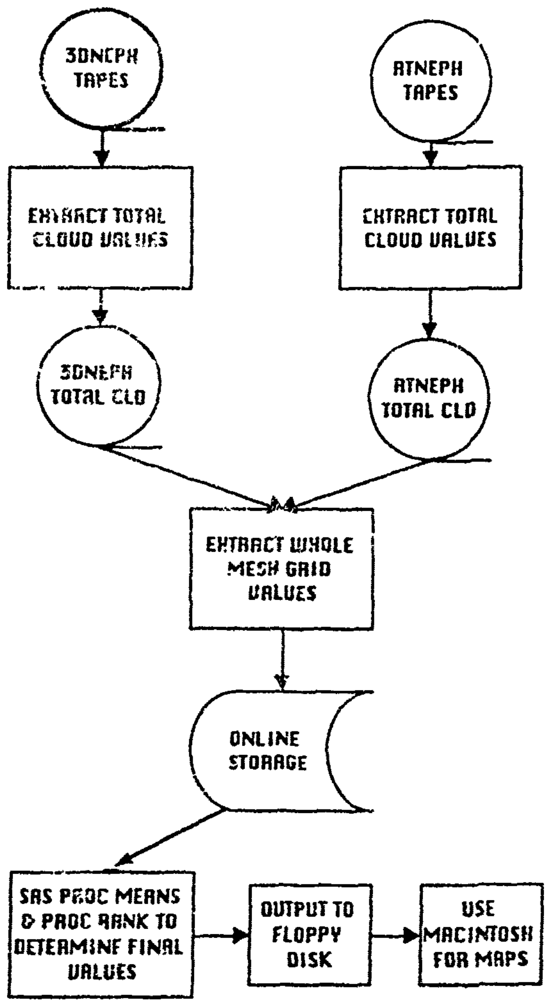
2.3 Data Type Comparisons. The 3DNEPH and RTNEPH models are similar, but the 3DNEPH model used 15 *fixed* layers in the atmosphere to record cloud data while the RTNEPH model uses four *floating* layers. Both models use the eighth-mesh polar-stereographic grid . Both provide data of the characteristics of the cloud cover for the grid point(s) in question, but only *total* cloud-cover value was used in this study.

- 3DNEPH data is archived by "NEPH BOX," with 6 months of data (January-June or July-December) on a 2,400-foot , 9-track tape.

- RTNEPH data is also archived by "NEPH BOX," but with 4 months of data (January-April, May-August, or September- December) on a 2,400-foot, 9-track tape.

For the entire globe and period of record used in this study (1977-1991), there were 1,680 3DNEPH tapes and 5,760 RTNEPH tapes. Together, they represented about 5,000 megabytes of raw data.

2.4 Data Computations. The enormous volume of raw data in these two databases far exceeded the on-line storage capacity of USAFETAC's IBM 3090 mainframe computer. Since all the data was stored on tape, it would have taken about 31 continuous 24-hour days just to *read in* all the data, even if the mainframe were capable of holding it. Therefore, USAFETAC was forced to look for a simpler way to process the data. The simplified method chosen is shown by the diagram below.



Even after simplification, many months were required to process and display the data. SAS software was used, primarily PROC MEANS for determining the mean monthly total cloud cover for each grid point and PROC RANK for ranking the year-months.

The processed data was downloaded from the mainframe to 3.5-inch diskettes, which were then read into an Apple Macintosh IIci computer and SPYGLASS TRANSFORM software for contouring and mapping. The final results are displayed in the appendix as familiar global Mercator projections for easy visual analysis. Although the maps in the appendix are black and white, color versions are available for special applications by calling USAFETAC/DOS, DSN 576-3543.

2.5 Data Analysis. Analysis of the monthly charts, as shown in the table below, showed no apparent trends. This was not a surprise, since cloudiness is expected to vary by year and month from one geographic location or climatic regime to another. In other words, there is no one single worldwide "cloudiest year" or "cloudiest month." It should be possible to compare these maps with years and months of known weather phenomena (e.g., ENSO or other climatic extremes), but such a comparison was not attempted during this study. Note that 1984 and 1985 show low cloudiness percentages for all months, but USAFETAC does not believe that these low percentages are due to the models; the changes are not that great and the overall trend toward the lower percentages began before the RTNEPH model became operational.

PERCENTAGE OF GRID POINTS WITH THE SAME YEAR AND MONTH OF MAXIMUM TOTAL CLOUD COVER. Asterisks (*) indicate less than 5%.

	77	78	79	80	81	82	83	84	85	86	87	88	89	90	91
Jan	*	9	6	*	10	8	11	*	*	5	18	5	7	6	*
Feb	7	11	1	*	10	8	11	*	*	13	8	*	7	6	*
Mar	*	10	4	10	12	11	13	*	*	15	*	*	*	*	
Apr	*	15	*	9	11	6	14	*	*	6	9	*	*	5	*
May	5	11	*	6	6	15	14	*	*	*	6	6	*	6	9
Jun	7	6	15	*	8	7	12	*	*	6	8	5	*	6	12
Jul	16	8	12	*	5	7	8	*	*	6	8	5	*	6	11
Aug	11	8	9	5	6	10	7	*	*	*	9	10	*	6	12
Sep	10	6	10	7	6	11	8	*	*	12	*	*	6	12	
Oct	8	5	7	12	5	19	*	8	7	*	8	*	*	5	7
Nov	6	5	8	14	8	15	*	5	6	*	5	*	6	5	8
Dec	7	5	7	15	8	12	*	*	11	6	6	*	6	5	*

3. SUMMARY. Using the methods outlined in this report, it was possible to process and analyze the 3DNEPH and RTNEPH databases for the entire period of record. This study only determined a *general* comparison of the two databases; we did not, for example, determine a year and month with the highest mean total cloud cover that covered the largest geographical area. Using similar methods, however, it should be possible to do an in-depth statistical study for limited geographical areas and the entire period of record. It should also be possible to use the data from this study to determine if and how a particular climatic event such as an ENSO or volcanic eruption might have affected a specific area or the entire planet. Further study and advanced statistical assessment is required, however, to answer specific questions relating to the models and cloud cover.

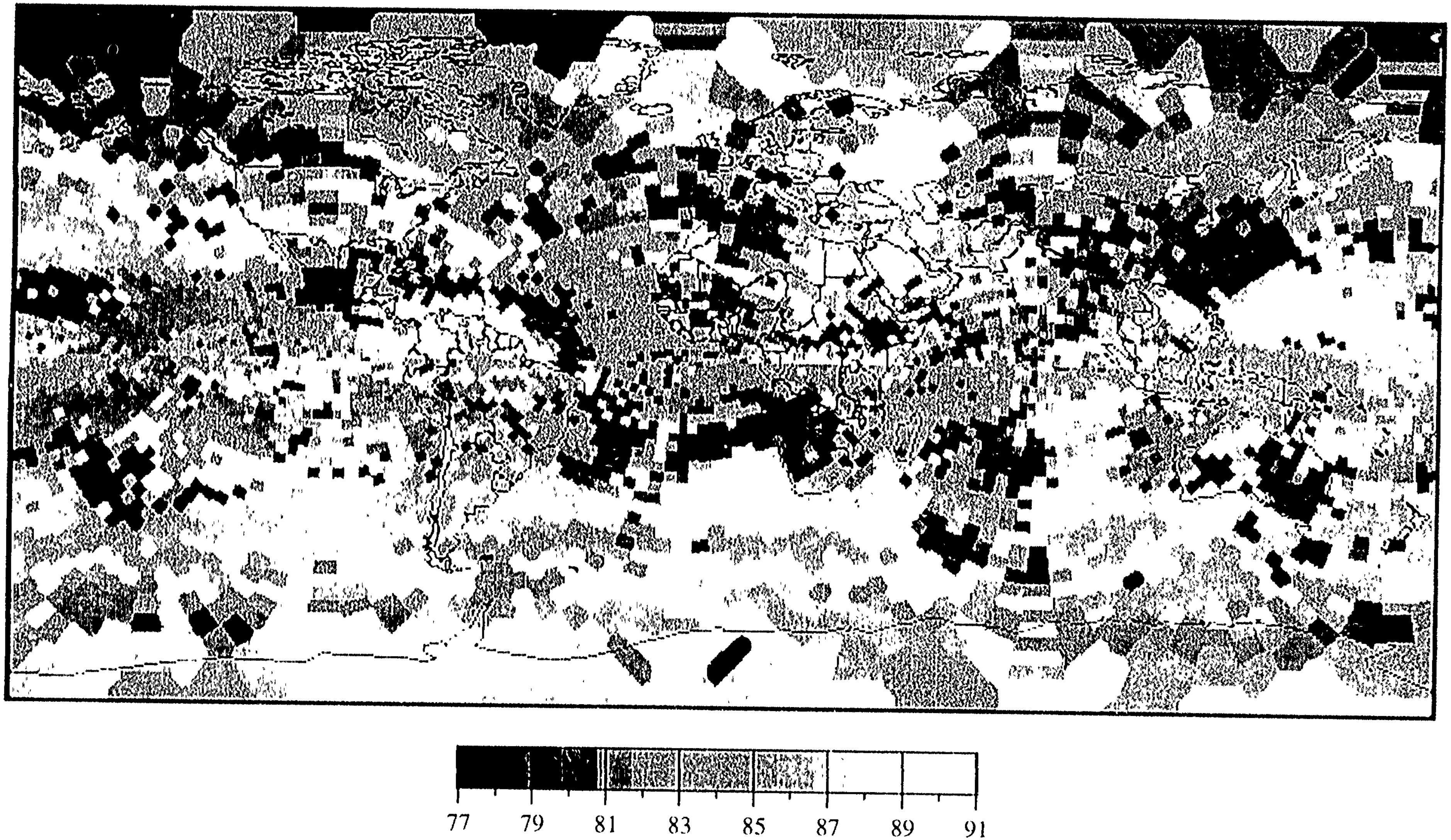
APPENDIX

MONTHLY YEAR OF MAX MEAN TOTAL CLOUD COVER

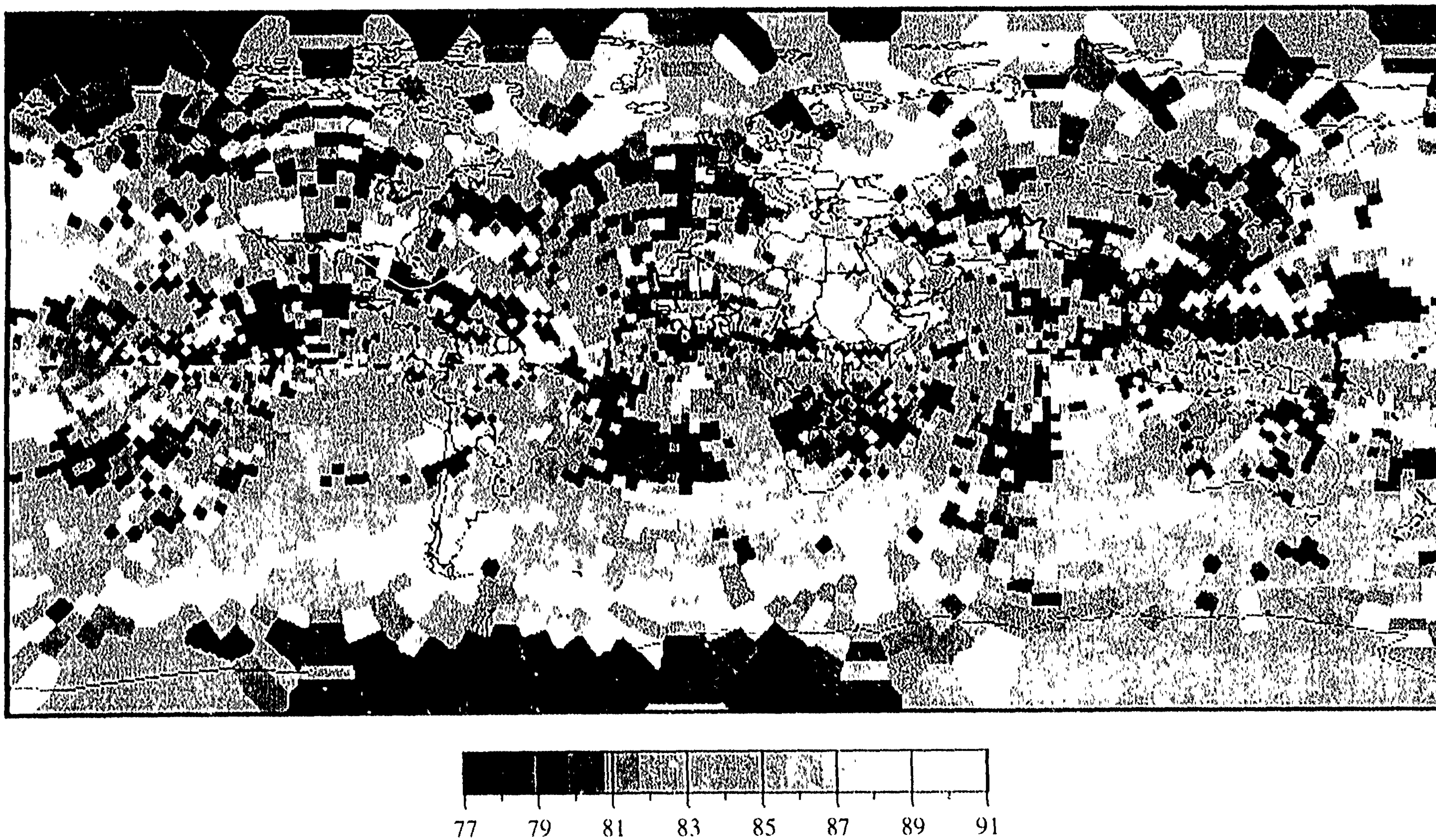
FROM 3DNEPH AND RTNEPH DATABASES

Study results month-by-month) are displayed in the appendix as familiar global Mercator projections for easy visual analysis. Although the maps are black and white, color versions are available for special applications by calling USAFETAC/ DOS, DSN 576-3543.

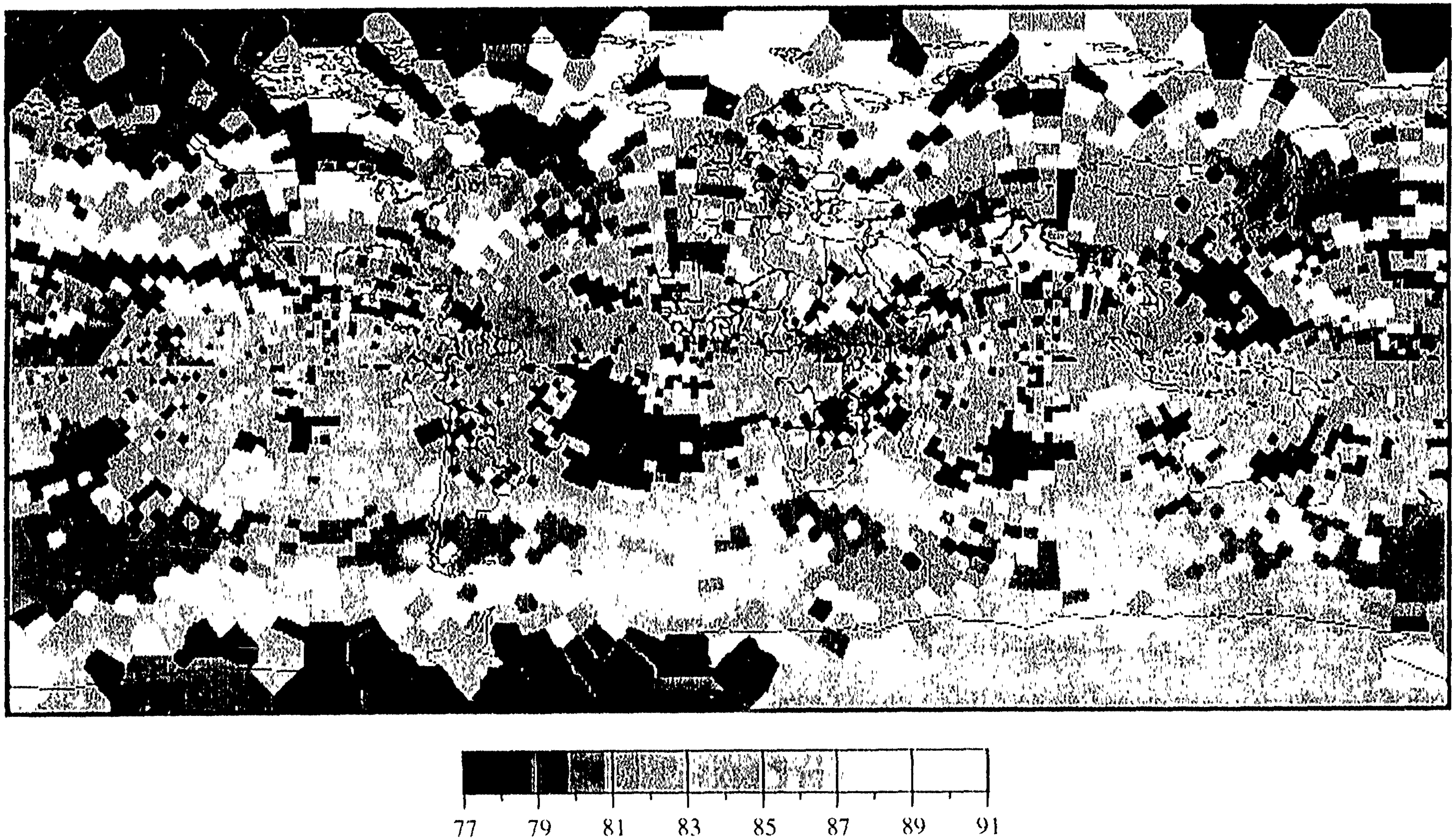
JANUARY
YEAR OF MAX MEAN TOTAL CLOUD COVER
FROM 3DNEPH AND RTNEPH DATABASES



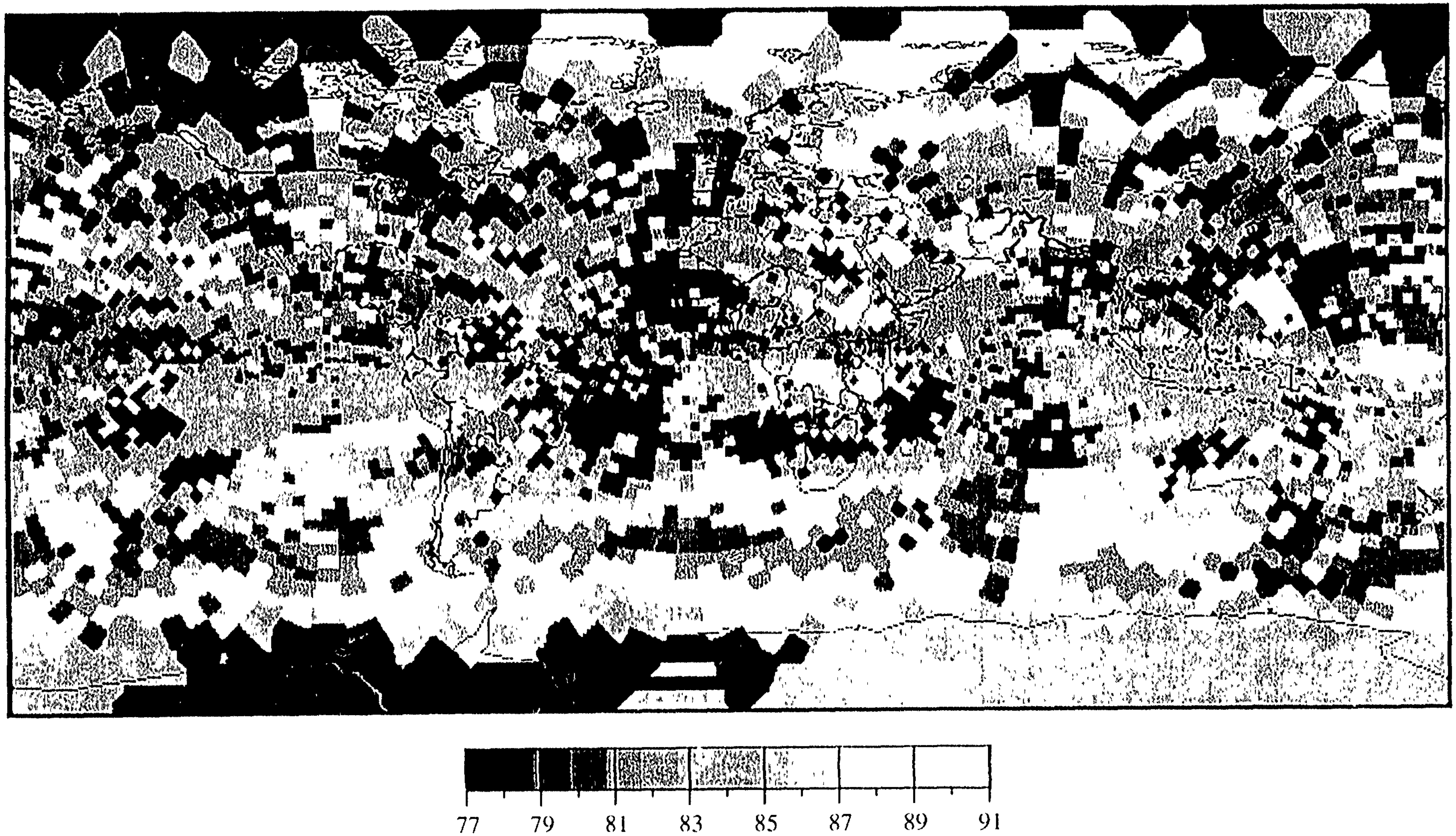
FEBRUARY
YEAR OF MAX MEAN TOTAL CLOUD COVER
FROM 3DNEPH AND RTNEPH DATABASES



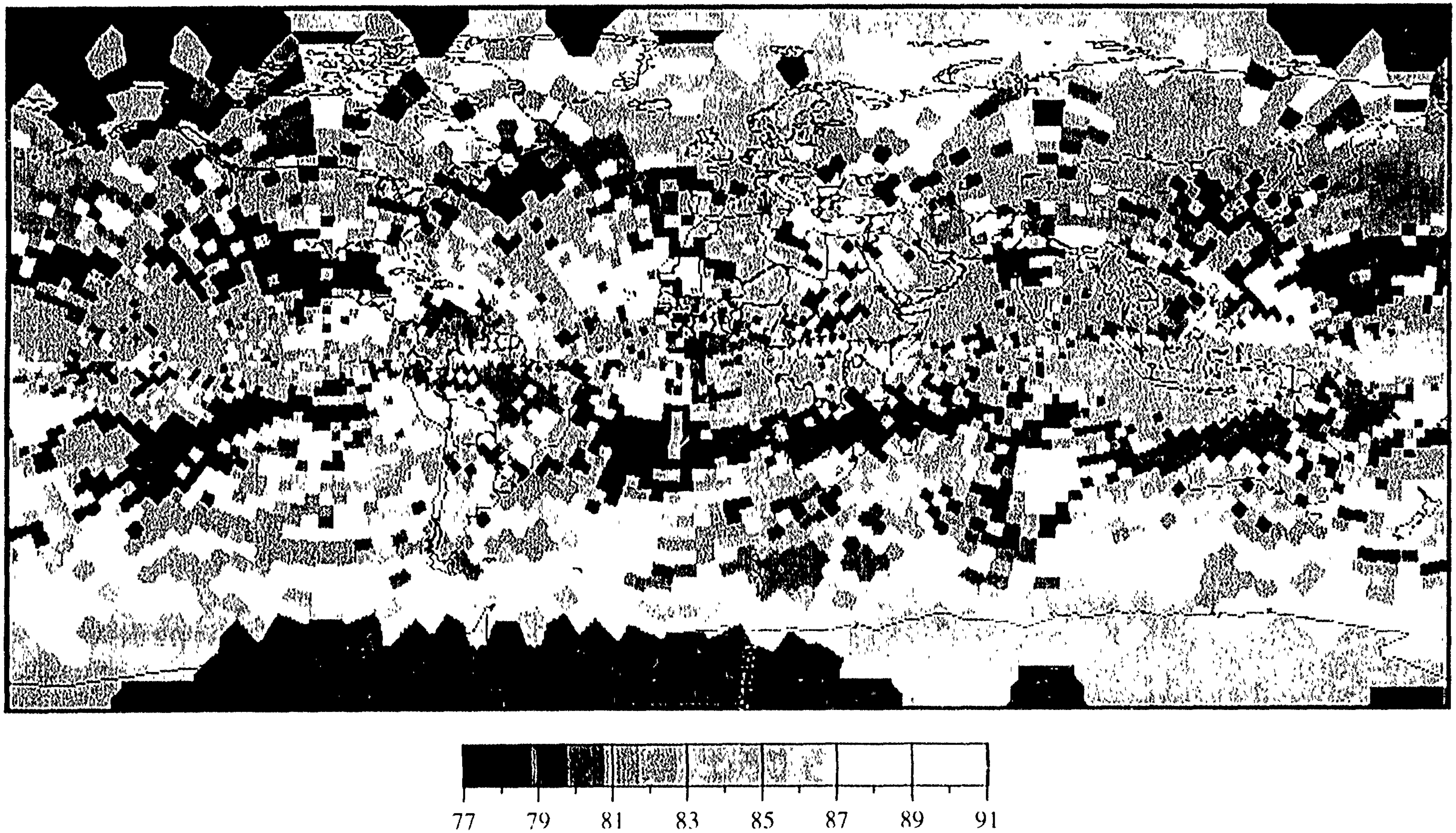
MARCH
YEAR OF MAX MEAN TOTAL CLOUD COVER FROM 3DNEPH AND RTNEPH DATABASES



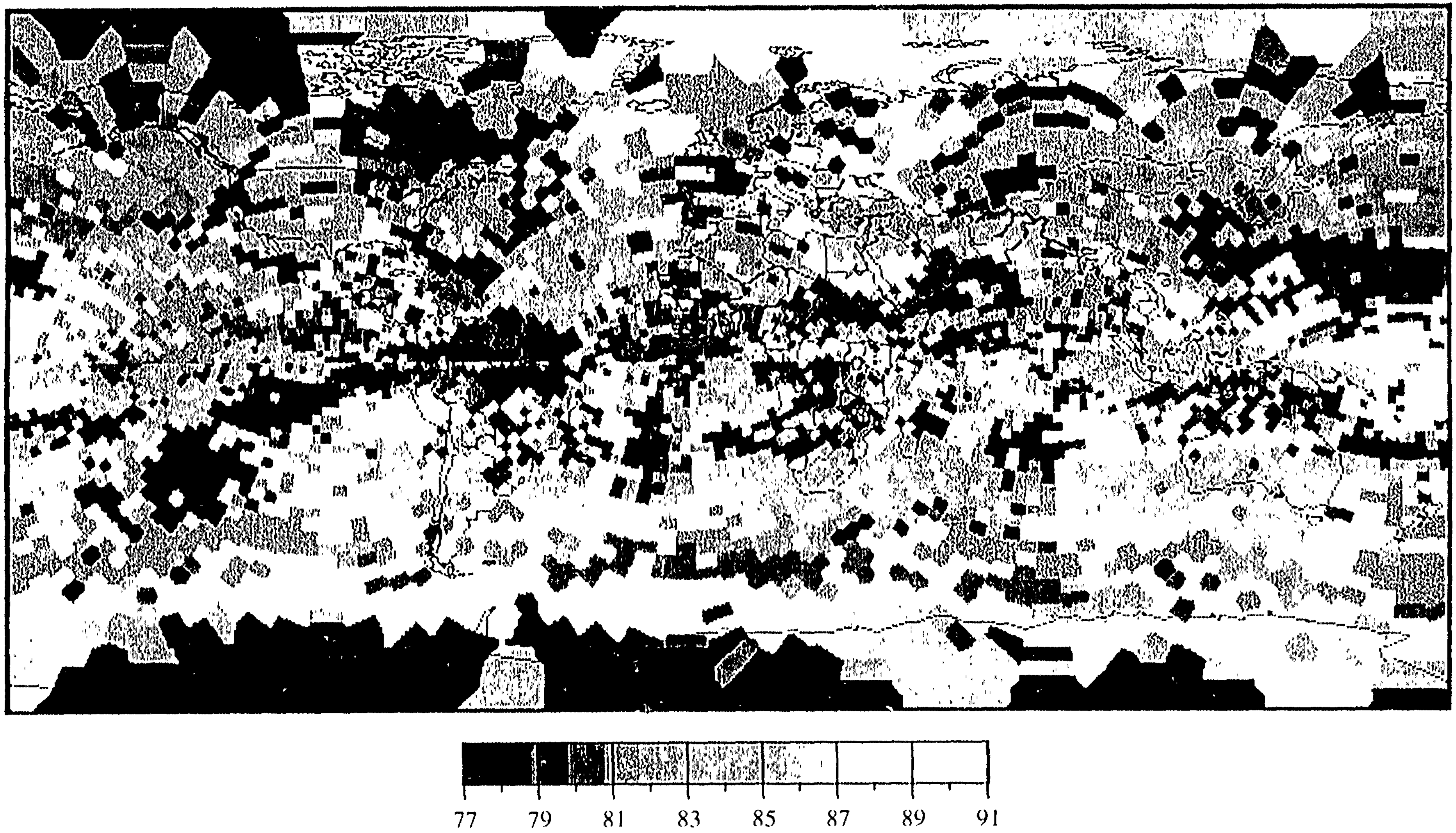
APRIL
YEAR OF MAX MEAN TOTAL CLOUD COVER
FROM 3DNEPH AND RTNEPH DATABASES



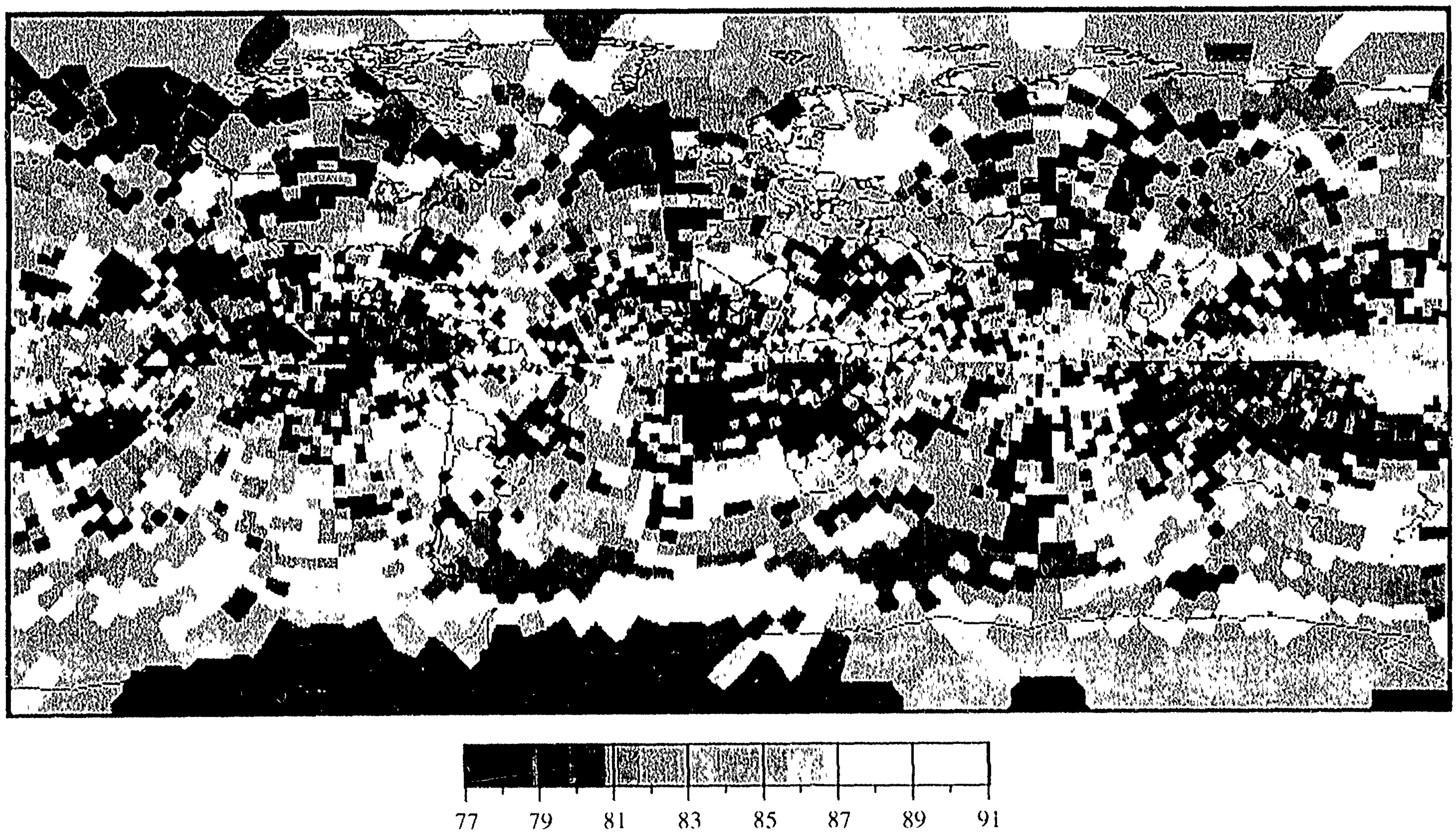
MAY
YEAR OF MAX MEAN TOTAL CLOUD COVER FROM 3DNEPH AND RTNEPH DATABASES



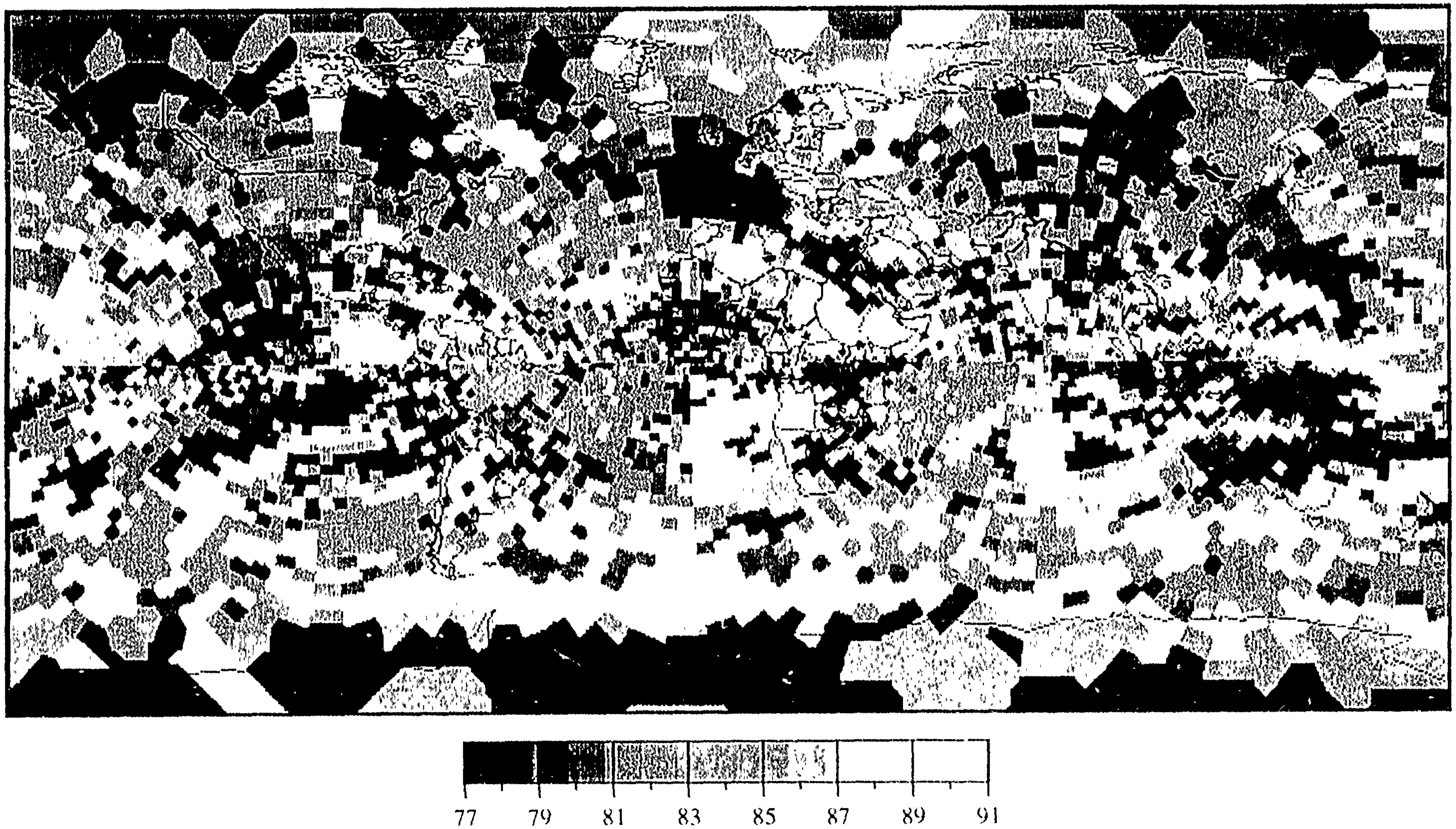
JUNE
YEAR OF MAX MEAN TOTAL CLOUD COVER
FROM 3DNEPH AND RTNEPH DATABASES



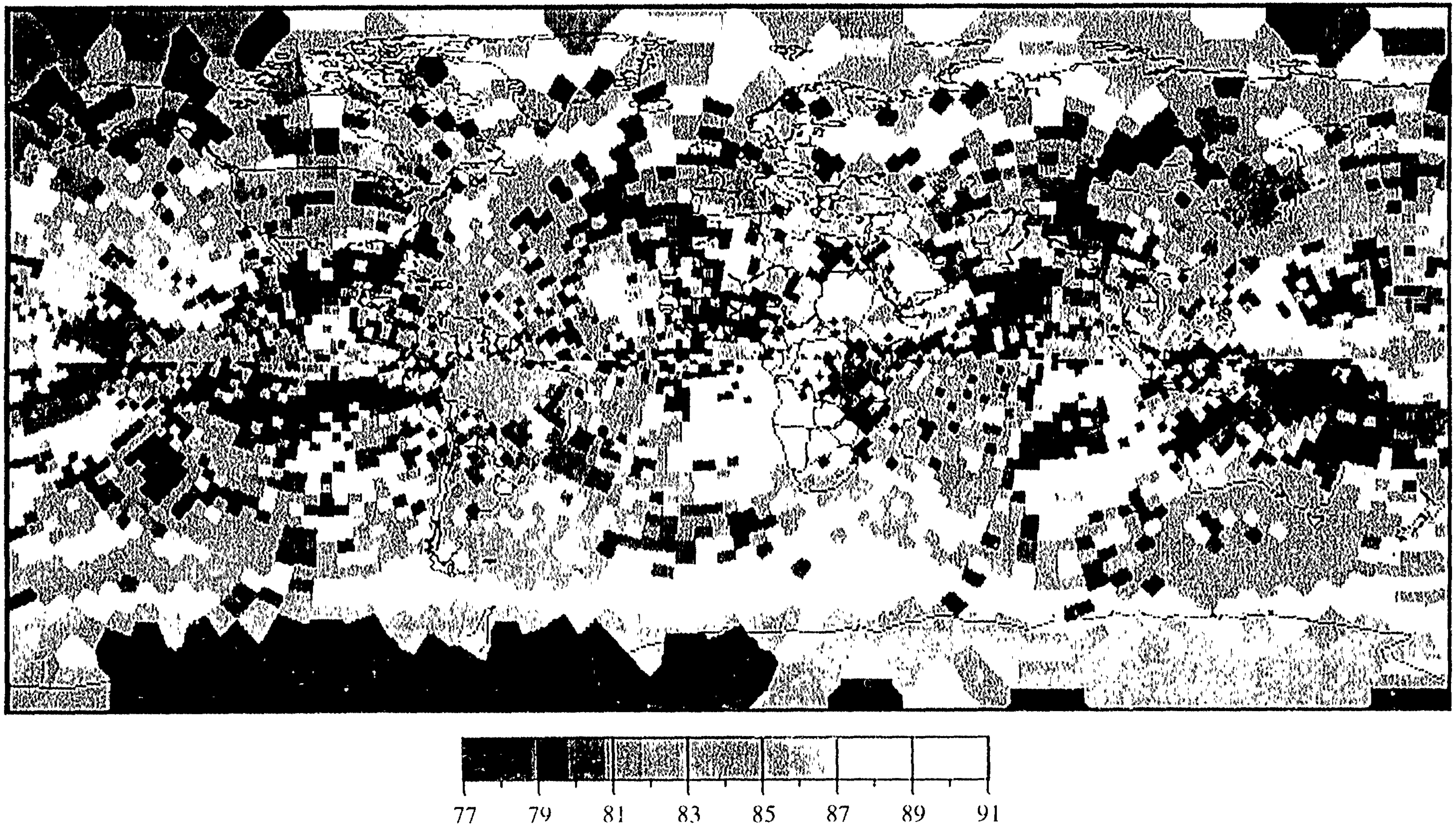
JULY
YEAR OF MAX MEAN TOTAL CLOUD COVER FROM 3DNEPH AND RTNEPH DATABASES



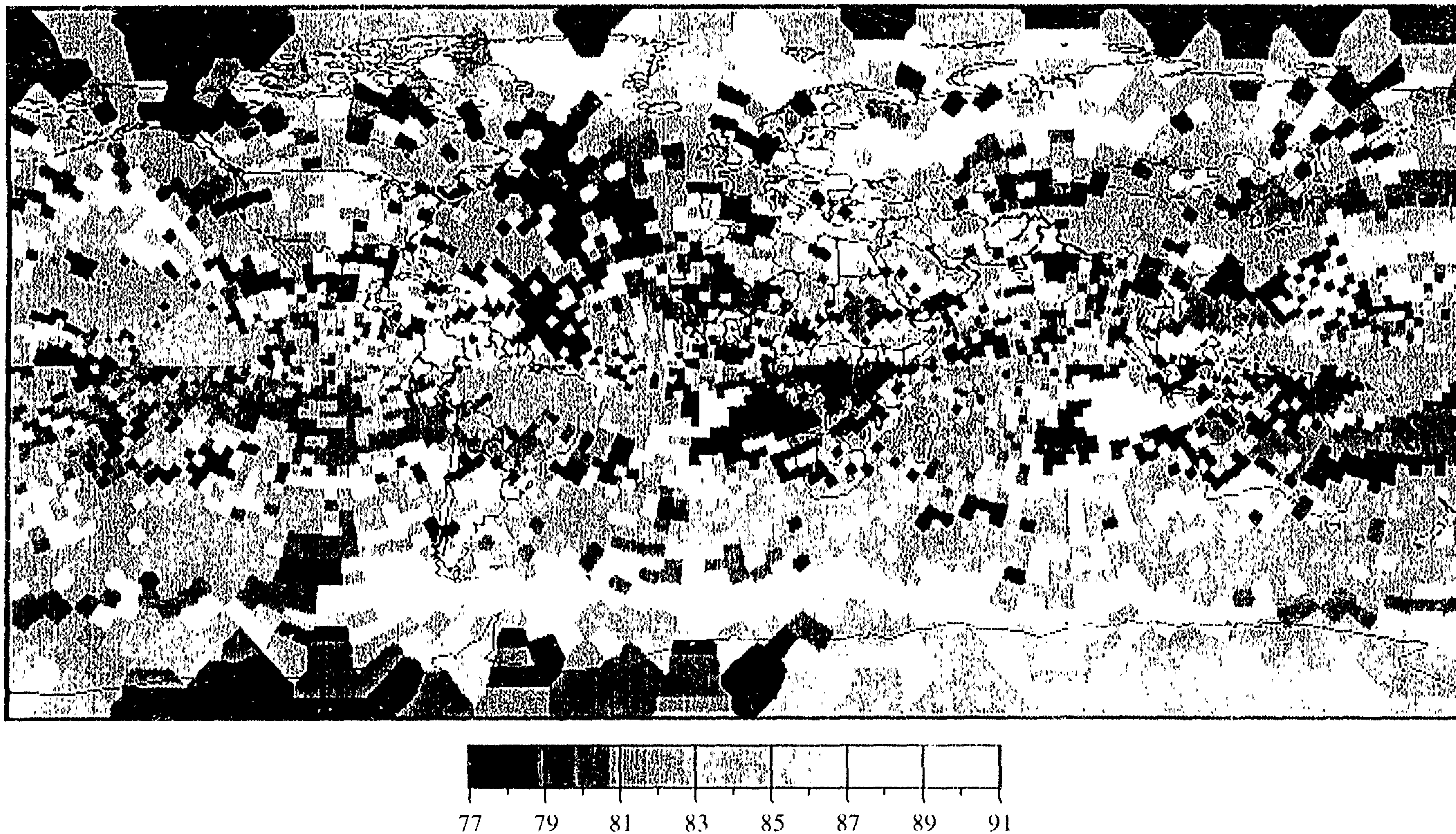
AUGUST
YEAR OF MAX MEAN TOTAL CLOUD COVER FROM 3DNEPH AND RTNEPH DATABASES



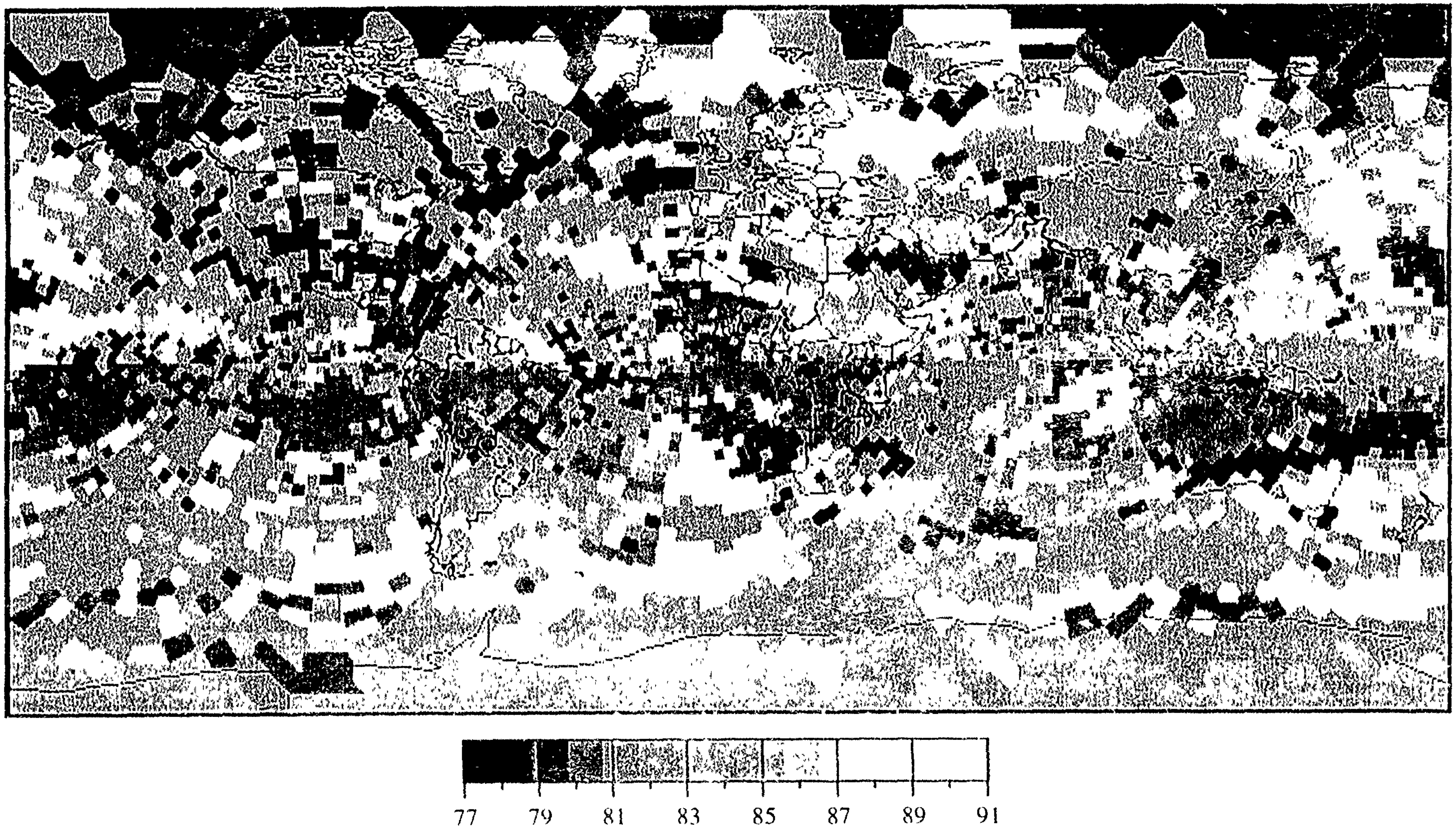
SEPTEMBER
YEAR OF MAX MEAN TOTAL CLOUD COVER
FROM 3DNEPH AND RTNEPH DATABASES



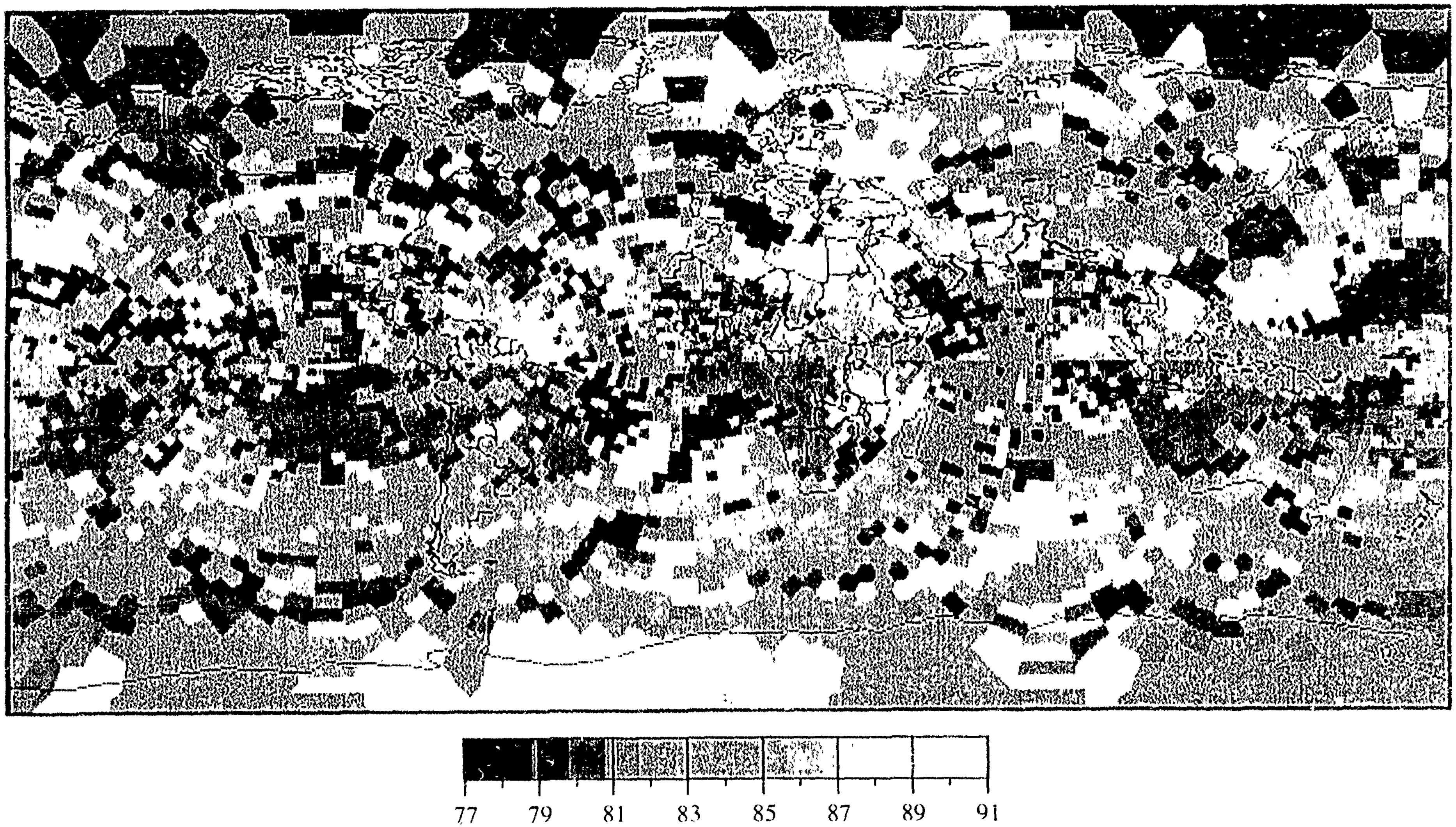
OCTOBER
YEAR OF MAX MEAN TOTAL CLOUD COVER FROM 3DNEPH AND RTNEPH DATABASES



NOVEMBER
YEAR OF MAX MEAN TOTAL CLOUD COVER
FROM 3DNEPH AND RTNEPH DATABASES



DECEMBER
YEAR OF MAX MEAN TOTAL CLOUD COVER FROM 3DNEPH AND RTNEPH DATABASES



DISTRIBUTION

HQ USAF/XOOCW, Rm BD927, Washington, DC 20330-5054 1
OSAF/SS, Rm 4C1052, Pentagon, Attn: Weather, Washington, DC 20330-6560 1
USTC J3/J4-OW, 508 Scott Dr., Bldg 1900, Scott AFB, IL 62225-5357 1
AWS/XTX/DO, 102 Losey St., Bldg 1521, Scott AFB, IL 62225-5118 1
Det 3, DOXW, PO Box 95004, Henderson, NV 89009-5004 1
Det 4, AWS, Bldg 91027, Hurlburt Fld, FL 32544-5000 1
Det 5, HQ AWS, Keesler AFB, MS 39534-5000 1
OL-B, HQ AWS, Hanscom AFB, MA 01731-5000 1
OL-K, HQ AWS, NEXRAD, 1200 Westheimer Dr., Norman, OK 73069-7902 1
OL-N, HQ AWS, ASL(SLCAS-BW-W), Bldg 1646, Rm 24, Missile Range, White Sands, NM 88002-5501 1
HQ AFGWC/DOM/SY, MBB39, 106 Peacekeeper Dr., Ste 2N3, Offutt AFB, NE 86113-4039 1
Det 7, AFGWC, E and 2nd St., Bldg 1750, Carswell AFB, TX 76127-5000 1
Det 11, AFGWC, Hickam AFB, HI 96853-5000 1
Det 40, AFGWC, APO AE 09494-5361 1
AFSFC/DOM, 715 Kepler Ave,Box 60, Falcon AFB, CO 80912-7160 1
OL-A, AFSFC, RE SE2, 325 Broadway, Boulder CO 80303-3328 1
Det 2, AFSFC, PO Box 2517, S. Hamilton, MA 01982-0517 1
Det 3, AFSFC, PO Box 261. Ramey Solar Obs, PO Box 261, ramey PR 00604-0261 1
Det 4, AFSFC, Observatory Rd., Bldg 912, Holloman AFB, NM 88330-5000 1
Det 5, AFSFC, Palehua Solar Obs Lab, Hickam AFB, HI 96853-5000 1
Det 8, AFSFC, Unit 6270, PSC 55, APO AE 09605-5000 1
Det 9, AFSFC, PSC 465, Learmonth Solar Obs, FPO AP 96550-2910 1
USAFETAC/DOL, 859 Buchanan St, Bldg 859, Scott AFB, IL 62225-5116 50
OL-A, USAFETAC, Federal Building, Rm 305, Asheville, NC 28801-2723 1
NCDC Library (D542X2), Federal Building, Asheville, NC 28801-2723 1
HQUSSPACECOM/J3W, 250 S. Peterson Blvd, STE 317, Bldg 1, Stop 7, Peterson AFB, CO 80914-3230 1
45WS, Bldg 423, C. St., Patrick AFB, FL 32925-6537 1
AFTAC/DOW/TN, 1030 Highway A1A, Patrick AFB, FL 32925-3002 1
30WS, Coral Rd., Bldg 21150, Vandenberg AFB, CA 93437-5000 1
21OSS/OGSW, Hamilton Rd., Stop 22, Peterson AFB, CO 80914-5000 1
SSD/MWA, PO Box 92966, Los Angeles, CA 90009-2960 1
SSD/IMO, PO Box 92960, Los Angeles, CA 90009-2960 1
SM-ALC/LH-AWS, McClellan AFB, CA 95652-5609 1
USAICS, Attn: ATSI-CDW, Ft Huachuca, AZ 85613-6000 1
Det 2, SMC/TDOR (Weather), 1080 Lockheed Way, Box 007, Bldg 1001, Onizuka AFB, Sunnyvale, CA 94088-1230 1
OD 4/DX, Onizuka AFB, CA 94088-3430 1
SSD OD 4, Onizuka AFB, CA 94088-3430 1
Det 3, Space Systems, Bldg 430, Stop 77, Buckley ANGB, CO 80011-9599 1
USAFA/DFP, Attn: Capt Paul Bellaire, Colorado Springs, CO 80840-5701 1
USAFA Dept of Economics & Geography, Colorado Spings, CO 80840-5701 1
AFMC/DOW, Bldg 266, Post 108P Chidlaw Rd.,Wright-Patterson AFB, OH 45433-5001 1
FASTC/TAW, 4115 Hebble Creek Rd., Ste 33, Wright-Patterson AFB, OH 45433-5637 1
ASD/WE, Bldg 91, 3rd St, Wright-Patterson AFB, OH 45433-6503 1
AFIT/CIR, Wright-Patterson AFB, OH 45433-6583 1
WL/DOA, Wright-Patterson AFB, OH 45433-6543 1
WL/DOW, Wright Patterson AFB, OH 45433-6543 1
645 WS/CC, Wright Patterson AFB, OH 45433-5000 1
46 TG/WE, Holloman AFB, NM 88330-5000 1
PL/WE, Kirtland AFB, NM 87117-5000 1
HQ AFOTEC/WE, Kirtland AFB, NM 87117-7001 1
RL/WE, Griffiss AFB, NY 13441-5700 1
ROME LAB/SUL,Corridor W, Ste 262, 26 Electronic Pkwy, Griffiss AFB, NY 13441-4514 1
AFCESA/WE, Tyndall AFB, FL 32403-5000 1
325 OSS/OSW, Florida Ave., Stop 22, Bldg 149, Tyndall AFB, IL 32403-5048 1

AFESC/RDXT, Bldg 1120, Stop 21, Tyndall AFB, FL 32403-5000 1
ESD/WE, Vandenberg Dr., Bldg 1624, Hanscom AFB, MA 01731-5000 1
PL/TSML, Research Library, Hanscom AFB, MA 01731-5000 1
PL/GP, Hansom AFB, MA 01731-5000 1
46 WS/CC, Eglin AFB,FL 31542-5000 1
AFFTC/WE, Edwards AFB, CA 93523-5000 1
SMC/SDW, PO Box 92960, Bldg 117, El Segundo, Los Angeles AFB, CA 90009-2960 1
UTTR/WE, Hill AFB, UT 84056-5000 1
USAFA/CWOSW, Air Field Dr., Bldg 9206, USAF Academy, CO 80840-5000 1
USCENTCOM/CCJ3-W, Bldg 540, MacDill Blvd, MacDill AFB, FL 33608-7001 1
ESMC/WE, Patrick AFB, FL 32925-5000 1
OL-A, AFCOS, Site R, Fort Ritchie, MD 21719-5010 1
USAFALCENT RA, Pope AFB, NC 28308-5000 1
CCSO/FL, Tinker AFB, OK 73145-6340 1
AFOSR/NL, Bolling AFB, DC 20332-5000 1
TFWC/WE, Nellis AFB, NV 89191-5000 1
SMC, Det 2/TDO, Onizuka AFB CA 94088-3430 1
AL/OEBE, 2402 East Drive, Brooks AFB, TX 78235-5114 1
Dept of Economics and Geography, USAFA, Colorado Springs, CO 80840 1
AMC/XOWR, Bldg P40 N, 402 Scott Dr,. Rm 132, Scott AFB, IL 62225-5363 1
ATC/DOTW, 244 F Street East, Suite #3, Randolph AFB, TX 78150-4325 1
CFA, C-2/SWO, APO AP 96258-0210 1
603 ACCS/WE, Unit 2051, APO AP 96278-5000 1
8OSS/WX, APO AP 96264-5000 1
PACAF/DOW, Bldg 1102, Hickam AFB, HI 96853-5000 1
Det 1, HQ PACAF, COMNAVMAR, PSC 489, Box 20, FPO AP 96540-0051 1
11 OPG/WE, 6900 9th Ste 205, Elmendorf AFB, AK 99506-5000 1
3 OSS/WE, 7th St., Bldg 32235, Elmendorf AFB, AK 99506-5000 1
USSTRATCOM/J3615, Rm L127, Bldg 522, 901 SAC Blvd, Offutt AFB, NE 68113-5000 1
ACC/DOW, Bldg 21, 30 Elm St, Ste 215, Langley AFB, VA 23655-2093 1
24WS, Unit 0640, APO AA 34001-5000 1
9 COS/AOSW, Bldg 1130, Shaw Dr., Shaw AFB, SC 29152-5410 1
1TSI/CDW, US Army Intel, Ft Huachuca AI, AZ 85613-5000 1
1 WXG, Bldg 168, Hardee St., Ft McPherson, GA 30300-5000 1
JSOC/Weather, P.O. Box 70239, Ft Bragg, NC 28307-5000 1
USAFE/DOW, Unit 3050, Box 15, APO AE 09094-5015 1
USAFE/DOWO, Unit 3050, Box 500, APO AE 09094-5015 1
17AF/DOW, Unit 4065, APO AE 09136-5000 1
HQ USEUCOM ECJ3, Unit 30400, Box 1000, APO AE 09128-4209 1
7WS, CINCUSAREUR/AREAWX, APO AE 09403-5000 1
Army Training and Doctrine Command, ATDO-IW (ATTN: SWO), Ft Monroe VA 23651-5000 1
COMNAVOCEANCOM, Code N312, Stennis Space Ctr, MS 39529-5000 2
COMNAVOCEANCOM (Capt Brown, Code N332), Stennis Space Ctr, MS 39529-5001 1
NAVOCEANO (Barnie Rau), Bldg 8100, Rm 203D, Stennis Space Ctr, MS 39522-5001 2
NAVOCEANO, Code 9220 (Tony Ortolano), Stennis Space Ctr, MS 39529-5001 1
Maury Oceanographic Library, Naval Oceanography Office, Stennis Space Ctr, MS 39522-5001 1
Naval Research Laboratory, Monterey, CA 93943-5006 1
Naval Research Laboratory, Code 4323, Washington, DC 20375 1
Naval Postgraduate School, Chmn, Dept of Meteorology, Code 63, Monterey, CA 93943-5000 1
Naval Eastern Oceanography Ctr (Clim Section), U117 McCAdy Bldg, Norfolk NAS, Norfolk, VA 23511-5000 1
Naval Western Oceanography Ctr, Box 113, Attn: Tech Library, Pearl Harbor, HI 96860-5000 1
Commanding Officer, Naval Polar Oceanography Center, 4301 Suitland Road, FOB #4, Washington, DC 20395-5108 . . 1
Naval Oceanography Command Ctr, COMNAVMAR Box 12, FPO San Francisco, CA 96630-5000 1
Commanding Officer, Naval Oceanography Command Ctr, PSC 819, Box 13, FPO AE, 09645-3200 1
NAVOCEANCOMDET, Federal Building, Asheville, NC 28801-2696 1
NAVOCEANCOMDET, Patuxent River NAS, MD 20670-5103 1

NAVOCEANCOMFAC, NAS North Island, San Diego, CA 92135-5130 1
Naval Air Warfare Center-Wpns Div, Geophysical Sciences Br, Code 3254, Point Mugu, CA 93042-5001 1
Armed Forces Medical Intel Ctr, InfoSvcs Div, Bldg 1607, Ft Detrick, Frederick, MD 21702-5004 1
Chief, APG Met Team, Bldg 1134, Attn: AMSTE-TC-AM CAB, Aberdeen Proving Ground, MD 21005-5001 1
Atmospheric Sciences Laboratory (SLCAS-AS-I 3 10-2c), White Sands Missile Range, NM 88002-5501 1
TECOM Atmos Sci Div, AMSTE-TC-AA (MacBlain), White Sands Missile Range, NM 88002-5504 1
White Sands Met Team, AMSTE-TC-AM (WS), White Sands Missile Range, NM 88002-5501 1
USA TECOM, ATTN: AMSTE-TC-AM (RE) TECOM Met Team, Redstone Arsenal, AL 35898-8052 1
Director, U.S.A.-CETEC, Attn: GL-AE (Whitmarsh), Fort Belvoir, VA 22060-5546 1
Technical Library, Dugway Proving Ground, Dugway, UT 84022-5000 1
HQ NATO Staff Meteorological Officer IMS/OPS APO AE 09724 1
NOAA/MASC Library MC5, 325 Broadway, Boulder, CO 80303-3328 2
NOAA Library-EOC4W5C4, Attn: ACQ, 6009 Executive Blvd, Rockville, MD 20852 1
NOAA/NESDIS (Attn: Nancy Everson, E/RA22), World Weather Bldg, Rm 703, Washington, DC 20233 1
NGDC, NOAA, Mail Code E/GC4, 325 Broadway, Boulder, CO 80333-3328 1
NWS W/OSD, Bldg SSM C-2 East-West Hwy, Silver Spring, MD 20910 1
NIST Pubs Production, Rm A635, Admin Bldg, Gaithersburg, MD 20899 1
NASA-MSFC-ES44, Attn: Dale Johnson, Huntsville, AL 35812-5000 1
DTIC-FDAC, Cameron Station, Alexandria, VA 22304-6145 2
AUL/LSE, Maxwell AFB, AL 36112-5564 1